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Preface

Jan Baetens[1] · Martin Kutrib[2]

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This special issue of Natural Computing is dedicated to cellular automata and related systems. It is based on AUTOMATA 2018, the 24th International Workshop on Cellular Automata and Discrete Complex Systems, held in Ghent, Belgium, June 20–22, 2018. AUTOMATA 2018 was organized by the Research Unit Knowledge-based Systems of the Department of Data Analysis and Mathematical Modelling of Ghent University. The event was an IFIP Working Conference and it hosted the annual meeting of the IFIP Working Group 1.5. AUTOMATA 2018 continued an annual series of workshops established in 1995 as a forum for the collaboration of researchers in the field of cellular automata and related discrete complex systems. The purpose of this workshop is to highlight the major advances in the field and the development of new tools, to support the development of theory and applications of CA and DCS and to identify and study within an inter- and multidisciplinary context, the important fundamental aspects, concepts, notions and problems concerning CA and DCS.

Cellular automata are among the first nature inspired models of computation, introduced by John von Neumann and Stanislaw Ulam to study self-replication and universality. Cellular automata are physically realistic massively parallel computation models that also have versatile applications as discrete models in physics and other natural sciences. Cellular automata obey realistic constraints of locality, uniformity, and parallelism which makes them an ideal model in these contexts. Other relevant properties such as time-reversibility and conservation laws can be conveniently imposed at will. In mathematics, cellular automata are studied as discrete dynamical systems in topological and symbolic dynamics.

From the articles presented at the workshop and included in a LNCS volume, 5 papers were selected. Their authors were invited to submit extended and improved versions to be published in this special issue. Each paper was carefully reviewed by two expert referees and finally the following 4 papers have been accepted for publication.

The paper *Sequentializing cellular automata* by Jarkko Kari, Ville Salo, and Thomas Worsch studies the problem of sequentializing a cellular automaton without introducing any intermediate states, and only performing reversible permutations on the tape. It gives a decidable characterization of cellular automata which can be written as a single sweep of a bijective rule from left to right over an infinite tape. Such cellular automata are necessarily left-closing, and they move at least as much information to the left as they move information to the right.

The second paper *Glider automorphisms and a finitary Ryan's theorem for transitive subshifts of finite type* by Johan Kopra presents a method that for any mixing subshift of finite type X constructs a reversible shift-commuting continuous map (automorphism) which breaks any given finite point of the subshift into a finite collection of gliders traveling into opposing directions. As an application a finitary Ryan's theorem is proved: the automorphism group $Aut(X)$ contains a two-element subset S whose centralizer consists only of shift maps. An example is given which shows that a stronger finitary variant of Ryan's theorem does not hold even for the binary full shift.

The third paper by Takahiro Tomita, Jia Lee, Teijiro Isokawa, Ferdinand Peper, Takayuki Yumoto, and Naotake Kamiura is titled *Reversible logic elements constructed on Turing tumble model*. It presents a mathematical model for the mechanical computer called Turing Tumble (TTM). It is shown that the model is computationally universal under the assumptions that a configuration of TTM is large enough and local interactions among elements can be transferred without limitations. Also, TTM has a constraint that a circuit in this model must be a directed acyclic graph,

✉ Jan Baetens
jan.baetens@ugent.be

Martin Kutrib
kutrib@informatik.uni-giessen.de

1 Department of Data Analysis and Mathematical Modelling, Ghent University, Coupure Links 653, 9000 Gent, Belgium

2 Institut für Informatik, Universität Giessen, Arndtstr. 2, 35392 Giessen, Germany

which is derived from the original Turing Tumble. This model can be useful for implementing computers with micrometer- or nanometer-scale.

The fourth paper *Hierarchies and undecidability results for iterative arrays with sparse communication* by Andreas Malcher investigates iterative arrays with restricted internal inter-cell communication. A quantitative measure for the communication is defined by counting the number of uses of the links between cells and it is differentiated between the sum of all communications of an accepting computation and the maximum number of communications per cell occurring in accepting computations. The computational complexity of both classes of devices is investigated and put into relation. A strict hierarchy depending on the maximum number of communications per cell is established and it is shown that almost all commonly studied decidability questions are not semidecidable for iterative arrays with restricted communication. Then, non-recursive trade-offs are proved among the iterative arrays providing the strict hierarchy depending on the maximum number of communications per cell.

We would like to thank the authors of all submitted papers for their contributions, and the reviewers for their insightful remarks and timely efforts in this process. We also wish to thank Joost Kok and Grzegorz Rozenberg for the opportunity to publish this special issue in Natural Computing.

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Jan M. Baetens
Martin Kutrib